

Mr. James Saric
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USEPA Region 5
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Subject:

Former Plainwell Impoundment TCRA July 2009 Post-Removal Bathymetry
Monitoring Results and Mid-Channel Prism Volume Remaining

Dear Mr. Saric:

This letter provides a summary of the bathymetric monitoring surveys conducted to date in the Kalamazoo River between the US-131 Bridge and the former Plainwell Dam as part of the Former Plainwell Impoundment Time-Critical Removal Action (TCRA). The *Supplemental Remedial Investigation/Feasibility Study Work Plan – Morrow Dam to Plainwell* (Area 1 SRI/FS Work Plan; ARCADIS BBL 2007a) requires periodic bathymetric monitoring in the former Plainwell Impoundment along ten transects originally established and surveyed by the U.S. Geological Survey (USGS) in 2000 (Rheume et al. 2002; shown on Figure 1).

The goal of the monitoring is to measure changes in the sediment surface elevations to calculate the loss of sediment in the "mid-channel prism" over time. The mid-channel was defined in the *Former Plainwell Impoundment Time-Critical Removal Action Design Report* (Design Report; ARCADIS BBL 2007b) as the area located at least 40 feet outward from top-of-bank.

In addition to the surveys conducted before and during construction, the Area 1 SRI/FS Work Plan states that the bathymetric surveys of the river bottom are to continue for 2 years after the completion of construction or until an 80% decrease of the mid-channel prism is observed. These surveys are to be conducted twice each year, including after any flow equal to or greater than 2-year return flows at the USGS Comstock gage. To date, two complete post-construction surveys have been completed – one in December 2008 (with a final transect surveyed in March 2009), and a second in July 2009. As of July 2009, over the section of the impoundment represented by Transects T01 through T10, an approximately 70% decrease of the mid-channel prism volume is observed.

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Surveys Completed to Date

Data from a USGS survey performed in fall 2000 along the ten transects were used to establish a working definition of the pre-impoundment river bottom elevations for the Design Report (ARCADIS BBL 2007b). These ten transects have been resurveyed four times – in September 2006 to establish a pre-construction baseline, in December 2007 at the end of the first construction season, in December 2008 following completion of sediment removal (Transect T01 was surveyed in March 2009), and most recently in July 2009. In the analysis presented here, the survey data collected in July 2009 are compared to previously collected data to track changes in the sediment profile and estimate the volumetric decrease of the mid-channel sediment prism since completion of the removal activities.

For purposes of this analysis of bathymetric changes, the baseline survey for the former Plainwell Impoundment is the fall 2000 USGS survey, which was used to establish the approximate elevation of the historical pre-impoundment river channel as well as the top-of-sediment elevation along ten transects (Figure 1). ARCADIS completed a survey of the sediment surface along Transects T03 through T10 in September 2006 prior to commencement of the TCRA to establish a pre-construction top-of-sediment profile along those transects that were considered in the design. Transects T01 and T02 were not included in the 2006 survey because the 2000 USGS data for those transects were adequate for design purposes.

ARCADIS performed during- and post-removal bathymetric surveys on December 19, 2007 and December 3 and 4, 2008, respectively, along the USGS-established transects. Due to the presence of the cofferdam structures, Transect T01 was not surveyed during the 2007 or 2008 surveys, but once the structures were removed, T01 was surveyed on March 26, 2009. Data from 2007 captured the changes after the first TCRA construction season, and data following the 2008 construction season provided the first complete post-removal sediment profile along all ten transects. At the time of the December 2008 survey, the water control structure was not completely dismantled, and was still maintaining a water level of approximately 701 feet (National Geodetic Vertical Datum, NGVD 1929). Bathymetric survey activities were most recently completed on July 14, 15, and 16, 2009 to provide the second complete post-removal sediment profiles along the ten transects. The July 2009 survey was performed 6 months post-construction, and captured the impact of the final removal of the water control structure as well as the effects of a high flow event in exceedance of the 2-year flood that occurred March 11-14, 2009.

Figure 1 shows the locations of the ten transects surveyed in July 2009 and also displays the limits of the sediment removal areas and the area represented by each transect, which are either established based on mid points between adjacent transects or removal area boundaries. Transect station location, water depth, surveyed top-of-sediment elevation, and general sediment type descriptions (based on indications from visual observation of surface sediment and steel probing rod observations) were recorded for each transect and are presented in Table 1. Average river flows of 692, 836, and 775 cubic feet per second (cfs) were recorded at the USGS gaging station at Comstock, Michigan, for July 14, 15, and 16, 2009, respectively.

Channel Cross-Section Bathymetry

Figures 2 through 11 present channel cross-sections from all of the bathymetric surveys for each of the ten transects. Top-of-sediment elevations surveyed in July 2009 are compared to previous survey results and to the USGS-measured pre-impoundment river bottom. The "as-built" approximate limits of the sediment removal areas shown on these cross-sections define the width of the mid-channel prism. In areas where no sediment was removed from either the north and/or south bank, the limits of the mid-channel prism width are defined as 40 feet outward from top-of-bank. The mid-channel prism remaining in July 2009 is shown on Figures 2 through 11 as the shaded area between the July 2009 sediment elevation and the pre-impoundment river bottom as defined by USGS. Mid-channel sediment prisms are not shown for Transects T03, T05, and T09 because the July 2009 surveyed sediment elevations are below the pre-impoundment elevation across those transects. Figures 2 through 11 also show the surveyed water levels from the 2007 through 2009 bathymetric monitoring events. The greatest changes in water and sediment elevations were observed at the downstream end of the former impoundment and diminish in the upstream direction. For example, the water elevation was more than 4 feet lower at Transects T01 through T06 after sediment and dam structure removal, but less than 2 feet lower at Transect T10, located farthest upstream from the former dam structure.

Mid-Channel Prism Volume Calculation

The change in volume of the mid-channel sediment prism to date was estimated using the 2006 (pre-removal) and the 2009 (second post-removal) survey data. The sediment prism volume was calculated for each transect as the product of the river length represented by each transect and the cross-sectional area of the mid-channel

sediment prism. A negative cross-sectional prism area was determined for Transects T03, T05, T5, and T09, where the July 2009 elevations are below the estimated pre-impoundment elevations. The length of the area around Transect T10 was calculated as the distance from the midpoint between Transects T09 and T10 and a point to within 50 feet downstream of the US-131 Bridge. The surface area of the sediment prism represented by each transect is shown on Figure 1.

Mid-channel sediment prism cross-sectional areas were determined using AutoCAD. Transect cross-sections, including the prism cross-sectional areas are shown on Figures 2 through 11. For pre-removal conditions, the cross-sectional area of the prism was defined as the area between the 2006 sediment surface elevation and the pre-impoundment river bottom within the approximate limits of removal. Note that Transects T01 and T02 were not surveyed in 2006, therefore sediment elevations measured in 2000 and 2007, respectively, were substituted for pre-removal conditions. The 2009 mid-channel sediment prism area is shown with hash marks on the transect cross-sections, Figures 2 through 11. For Transects T03, T05, and T09, the present July 2009 sediment elevation is lower than the 2000 USGS pre-impoundment elevation; therefore, the area below the estimated pre-impoundment bottom elevation was calculated to be negative, or in other words, the volume lost is greater than 100% of the estimated initial volume present. This may be related to inaccuracy in the estimated pre-impoundment bottom elevation, or the river may actually be incising below that elevation. The 2006 and 2009 mid-channel prism areas as determined in AutoCAD are listed in Table 2.

The volume of the mid-channel sediment prism for each transect area for both pre-removal and current conditions was calculated as the product of the channel length represented by a transect and the mid-channel prism cross-sectional area. By comparing the results of the 2000/2006 and 2000/2009 calculations, the remaining sediment volume is estimated. Additionally, for transects where the 2009 prism volume is negative (i.e. current sediment elevations are below the estimated pre-impoundment river bottom), the current prism volumes for Transects T03, T05, and T09 were set to zero in a second estimate of the total prism volume remaining. The volume change relative to 2006 for Transects T03, T05, and T09 is thereby limited to 100% reduction in this case. Mid-channel sediment prism volume calculations for both approaches are presented in Table 2.

Remaining Prism Volume Calculation

As shown on Table 2, the total mid-channel sediment volume decreased from approximately 88,000 cubic yards (cy) before the TCRA to approximately 26,000 cy currently – a net decrease of 70%. At Transects T01 through T07, the sediment prism decreased from approximately 68,000 cy in 2006 to approximately 16,000 cy in 2009, a net loss of 77% (23% remaining). Upstream of Transect T07, at Transects T08, T09, and T10, the sediment prism decreased from approximately 20,000 cy to 11,000 cy, a net loss of 47% (53% remaining). With the volume change at Transects T03, T05 and T09 limited to 100% reduction, the total mid-channel sediment volume decreased to 62% reduction with 70% reduction in Transects T01 through T07.

On an individual basis, all ten transects indicate net volume losses compared to pre-removal conditions. Three of the ten transects (T03, T05, and T09) indicate a prism reduction of greater than 100% because current sediment elevations are below the pre-impoundment surface elevation. Review of Transects T01 and T02 indicates erosion is occurring at all locations across the transect relative to pre-removal conditions, with some survey points indicating approximately 2 to 3 feet of sediment loss and some locations still exhibiting top-of-sediment elevations close to pre-removal elevations. Up to 4 to 5 feet of sediment remain above the estimated pre-impoundment river bed elevation at certain locations along Transects T01 and T02.

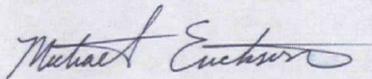
The longitudinal mid-channel sediment profile is presented as Figure 12, and shows a comparison of the pre- and post-TCRA sediment surface elevations to the pre-impoundment sediment surface elevation determined by USGS.

The Area 1 SRI Work Plan calls for the continuation of the bathymetric surveys for a 2-year period or until an 80% decrease of the mid-channel prism is observed. The calculations presented herein will be updated with subsequent survey data to track the reduction in the mid-channel prism volume. The next survey currently planned for November 2009. If results of the next bathymetric survey indicate that the 80 percent prism-loss endpoint has been reached, then we may notify USEPA of the completion of bathymetric monitoring of the prism.

If you have any questions, please contact me directly.

Sincerely,

ARCADIS



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Associate Vice President

Copies:

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Enclosures:

Table 1 – July 2009 Bathymetric Survey in the Former Plainwell Impoundment
Table 2 – Mid-Channel Sediment Prism Volume Calculations as of July 2009
Figure 1 – Bathymetry Transects Plainwell TCRA Area
Figures 2-11 – Channel Cross Section at USGS Transect T01-T10
Figure 12 – Longitudinal Profile of Mid-Channel Sediment Prism

References

ARCADIS BBL. 2007a. *Supplemental Remedial Investigation/Feasibility Study Work Plan – Morrow Dam to Plainwell* (Area 1 SRI/FS Work Plan). February 2007.

ARCADIS BBL. 2007b. *Former Plainwell Impoundment Time-Critical Removal Action Design Report* (Design Report). February 2007.

Rheaume, S. J., C. M. Rachol, D. L. Hubbell, and A. Simard. 2002. Sediment Characteristics and Configuration within Three Dam Impoundments on the Kalamazoo River, Michigan, 2000. U.S. Geological Survey Water-Resources Investigations Report 02-4098.

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Tables

Kalamazoo River Study Group
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Supplemental Remedial Investigations/Feasibility Studies
Former Plainwell Impoundment TCRA July 2009 Post-Removal Bathymetry Monitoring Results
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Table 1 -- July 2009 Bathymetric Survey in the Former Plainwell Impoundment

Transect - Station ID	Water Depth (ft)	Top of Sediment Elevation (ft, NGVD 1929)	Probe Depth (ft)	Description
T01 0+00	NA	701.1	NA	River Run Rock
T01 0+10	2.2	697.6	NA	River Run Rock, Restoration Materials
T01 0+20	3.0	696.7	NA	River Run Rock, Restoration Materials
T01 0+30	3.1	696.8	0.2	Gray Brown Silty Clay, Trace Fine Gravel
T01 0+40	1.3	698.5	2.0	Gray Brown Silty Clay, Trace Fine Gravel
T01 0+50	0.6	699.4	2.8	Gray Brown Silty Clay, Trace Medium Sand
T01 0+60	2.0	698.1	1.7	Gray Brown Silty Clay, Trace Coarse Sand, Fine Gravel
T01 0+70	2.0	698.0	1.9	Gray Brown, Silty Clay, Trace Coarse Sand, Fine Gravel
T01 0+80	1.0	699.2	3.0	Gray Brown Silty Clay, Trace Fine to Medium Sand
T01 0+90	0.8	699.4	3.0	Gray Brown Silty Clay, Trace Fine to Medium Sand
T01 1+00	1.0	699.2	3.0	Gray Brown Silty Clay, Trace Fine to Medium Sand
T01 1+10	3.0	697.2	1.2	Gray Brown Silty Clay, Trace Fine to Medium Sand, Gravel
T01 1+20	3.0	697.6	1.0	Gray Brown Silty Clay, Trace Fine to Medium Sand, Gravel
T01 1+30	2.9	697.9	1.6	Gray Brown Silty Clay, Trace Fine to Medium Sand, Gravel
T01 1+40	1.7	699.0	3.0	Gray Brown Silty Clay, Trace Fine to Medium Sand, Trace Fine Gravel
T01 1+50	1.8	698.8	2.6	Gray Brown Silty Clay, Trace Fine to Medium Sand
T01 1+60	1.8	698.9	2.6	Gray Brown Silty Clay, Trace Fine to Medium Sand
T01 1+70	5.6	695.0	0.0	Hard Rock Bottom, No Recovery For Sample
T01 1+80	5.0	695.5	0.7	Brown Fine to Medium Sand, Fine Gravel
T01 1+90	1.4	699.2	2.1	Gray Brown Silty Clay
T01 1+98	NA	701.4	NA	Top of Bank, 3 feet from Edge of Water, Restoration Rock
T02-01	NA	703.6	NA	Top of Bank, ~2 feet above River Run Rock
T02-02	NA	700.6	NA	Edge of Water, River Run Rock, Restoration Materials
T02-03	4.3	696.5	NA	River Run Rock, Restoration Materials
T02-04	4.0	696.7	0.9	Bottom Edge of Prism, Fine to Medium Gravel, Gray Black Silt, Clay, Trace Fine to Medium Sand
T02-05	0.0	701.0	3.9	Top of Prism, Gray Brown Silty Clay, Fine to Medium Sand
T02-06	0.1	700.5	3.5	Top of Prism, Gray Brown Silty Clay, Fine to Medium Sand
T02-07	2.3	698.8	0.7	Top of Prism, Gray Brown Silty Clay, Fine to Medium Sand
T02-08	2.1	698.6	1.7	Top of Prism, Gray Brown Silty Clay, Fine to Medium Sand
T02-09	2.2	698.4	1.7	Top of Prism, Gray Brown Silty Clay, Fine to Medium Sand
T02-10	3.1	697.5	0.9	Top of Prism, Gray Brown Silty Clay, Fine to Medium Sand
T02-11	2.9	697.9	1.1	Within 40 feet of Removal Area, Gray Brown Silty Clay, Fine to Medium Sand
T02-12	5.7	695.2	0.0	Hard Rock Bottom, No Recovery For Sample
T02-13	5.8	695.0	0.1	Hard Rock Bottom, No Recovery For Sample
T02-14	3.2	697.3	1.8	Gray Brown Silty Clay, Trace Fine Sand
T02-15	1.0	699.6	4.2	Gray Brown Silty Clay, Trace Fine Sand
T03-01	NA	704.8	NA	Restoration Materials, Heavy Vegetation, 6 feet, River Run Rock

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Transect - Station ID	Water Depth (ft)	Top of Sediment Elevation (ft, NGVD 1929)	Probe Depth (ft)	Description
T03-02	NA	702.5	NA	River Run Rock, Restoration Materials, ~10 feet from Edge of Water
T03-03	1.4	699.8	NA	River Run Rock, Restoration Materials
T03-04	7.0	697.1	0.6	Edge of River Run Rock, Restoration, Gray Brown Silty Clay, Fine to Medium Sand, Fine to Medium Gravel
T03-05	7.4	693.6	2.6	Gray Black, Silty Clay, Fine to Coarse Sand, Fine to Medium Gravel
T03-06	7.0	693.9	0.6	Medium to Coarse Sand, Trace Fine Sand, Fine to Medium Gravel, Little Recovery
T03-07	6.8	694.0	0.3	Fine to Medium Gravel, Fine to Coarse Sand, Trace Silty Clay
T03-08	6.5	694.4	0.4	Gray Brown Silty Clay, Trace Fine to Medium Sand, Trace Fine Gravel
T03-09	6.0	695.0	1.0	Brown Fine to Medium Gravel, Trace Fine to Coarse Sand
T03-10	5.8	695.0	0.3	Fine to Medium Gravel, Gray Brown Silty Clay, Trace Fine Sand
T03-11	5.1	695.8	0.2	Fine to Medium Gravel, Brown Fine to Medium Sand, Trace Calcareous Brown Rock Fragments
T03-12	4.7	696.2	1.0	Gray Brown Fine to Coarse Sand, Fine Gravel, Trace Organics - Dead Leaves, Stems, Wood
T03-13	3.0	697.8	0.9	Gray Black Silty Clay
T03-14	NA	701.4	NA	Top of Bank, Restoration Material, Edge of Water ~2 feet
T03-15	NA	702.1	NA	Top of Bank, Restoration Material, Edge of Water ~2 feet
T04-01	NA	704.7	NA	Top of Bank, Above River Run Rock, High Vegetation
T04-02	NA	701.7	NA	River Run Rock
T04-03	NA	701	4.1	3 feet from Edge of Water/Not Part of Removal Area
T04-04	1.6	699.4	2.2	Gray Brown Silty Clay/Trace Fine Gravel
T04-05	3.4	697.1	0.6	Gray Brown Silty Clay/Trace Fine Gravel
T04-06	4.1	696.5	0.8	Gray Brown Silty Clay
T04-07	5.3	695.5	0.7	Gray Brown Silty Clay/Trace Fine Gravel
T04-08	6.5	694.2	0.2	Medium to Coarse Sand Over Hard Rock Bottom, No Recovery for Sample
T04-09	4.4	696.3	1.8	Gray Brown Silty Clay
T04-10	4.7	695.8	2.4	Gray Brown Silty Clay
T04-11	5.2	695.5	3.0	Gray Brown Silty Clay
T04-12	5.1	695.5	2.7	Gray Brown Silty Clay
T04-13	1.8	698.9	5.0	Gray Brown Silty Clay
T04-14	NA	701.5	NA	Top of Bank, 5 feet from Edge of Water into Restoration Material
T04-15	NA	701.9	NA	Top of Bank, 10 feet from Edge of Water into Restoration Material
T05-01	0.0	708.0	NA	Steep Bank High Vegetation
T05-02	0.0	702.9	2.1	5-10 feet From Edge of Water/Not Part of Removal Area
T05-03	0.2	700.7	3.3	Gray Brown Silty Clay/Trace Organic Roots
T05-04	1.9	699.1	1.6	Gray Black Silty Clay
T05-05	3.5	697.7	0.3	Gray Black Silty Clay/Fine to Medium Gravel
T05-06	4.3	696.6	0.1	Hard Rock Bottom/No Recovery for Sample
T05-07	5.2	695.6	0.1	Hard Rock Bottom/No Recovery for Sample
T05-08	4.2	696.6	0.1	Hard Rock Bottom/No Recovery for Sample

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Transect - Station ID	Water Depth (ft)	Top of Sediment Elevation (ft, NGVD 1929)	Probe Depth (ft)	Description
T05-09	4.1	696.6	0.0	Hard Rock Bottom/No Recovery for Sample
T05-10	4.3	696.4	0.0	Hard Rock Bottom/No Recovery for Sample
T05-11	4.1	696.5	0.0	Hard Rock Bottom/No Recovery for Sample
T05-12	4.2	696.7	0.0	Hard Rock Bottom/No Recovery for Sample
T05-13	3.2	697.5	0.6	Fine to Medium Gravel/Medium to Coarse Sand
T05-14	2.1	698.6	2.0	Fine to Medium Gravel/Fine to Coarse Sand
T05-15	0.0	701.5	NA	Top of Bank, 3 feet from Edge of Water
T06-01	NA	704.3	NA	Out of Water - 10 ft, Heavy Vegetation
T06-02	NA	701.4	NA	River Run Rock
T06-03	1.5	699.1	0.0	River Run Rock
T06-04	4.5	700.0	0.4	Brown Silty Clay/Trace Fine to Medium Sand/Fine to Medium Gravel
T06-05	2.2	699.1	1.4	Gray Black Silty Clay/Trace Fine to Medium Sand/Fine to Medium Gravel
T06-06	2.1	699.3	1.4	Gray Black Silty Clay/Trace Fine to Medium Sand
T06-07	2.2	698.9	1.2	Gray Black Silty Clay/Trace Fine to Medium Sand
T06-08	2.8	698.5	0.2	Brown Silty Sand/Fine to Medium Sand/Fine to Medium Gravel
T06-09	2.8	698.5	0.2	Brown to Black Silty Clay/Fine to Medium Sand/Fine to Medium Gravel
T06-10	1.6	699.7	0.8	Brown to Black Silty Clay
T06-11	1.2	700.0	1.6	Brown to Black Silty Clay with Trace Organics, Leaves, Twigs
T06-12	3.3	697.9	0.0	Hard Rock Bottom
T06-13	3.1	698.2	0.3	Brown Fine to Medium Gravel/Trace Fine Sand/Trace Silt/Calcareous Broken Rock Fragments
T06-14	2.9	698.4	0.3	Gray Brown Fine to Medium Sand/Fine to Medium Gravel/Trace Silt
T06-15	NA	702.1	NA	Top of Bank - 2 ft from Edge of Water
T07-01	NA	706.9	NA	River Run Rock
T07-02	0.9	701.2	1.2	Gray Black Silty Clay/Trace Organic Roots
T07-03	1.4	700.5	1.0	Gray Black Silty Clay/Trace Organic Roots
T07-04	2.0	700.0	0.6	Gray Black Silty Clay/Trace Organic Roots
T07-05	2.4	699.6	0.6	Gray Black Silty Clay/Trace Organic Roots
T07-06	3.0	699.1	0.0	Hard Rock Bottom/No Recovery
T07-07	3.0	699.1	0.0	Hard Rock Bottom/No Recovery
T07-08	3.2	698.7	0.2	Hard Rock Bottom/No Recovery
T07-09	1.5	700.4	1.5	Gray Black Silty Clay/Trace Organic Roots/Calcareous Broken Rock Fragments
T07-10	2.8	698.5	0.4	Gray Brown Fine to Coarse Sand/Fine to Medium Gravel
T07-11	3.1	699.1	0.0	Boulder and Rock
T07-12	2.8	699.3	0.0	Rock/Coarse Gravel
T07-13	2.0	700.0	0.2	Fine to Medium Gravel/Brown Fine to Medium Sand
T07-14	1.4	700.4	6.2	Gray Silt/Clay/Fine to Medium Gravel with Strong Odor
T07-15	NA	704.6	NA	Top of Bank Erosion Control Matting

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Transect - Station ID	Water Depth (ft)	Top of Sediment Elevation (ft, NGVD 1929)	Probe Depth (ft)	Description
T08-01	NA	704.4	NA	Top of Bank, Restoration Material, High Vegetation
T08-02	1.7	701.2	1.4	Gray Black Silty Clay
T08-03	4.0	701.9	2.0	Medium Gravel
T08-04	3.6	702.2	0.0	No Recovery
T08-05	1.4	701.3	0.6	Gray Black Silty Clay, Trace Fine Gravel
T08-06	1.2	701.1	0.8	Gray Black Silty Clay, Trace Fine Gravel
T08-07	1.9	700.7	0.4	Gray Black Silty Clay, Trace Fine Gravel
T08-08	1.8	700.9	0.6	Gray Black Silty Clay, Trace Fine Gravel
T08-09	1.5	701.1	0.4	Gray Black Fine to Medium Gravel, Calcareous Broken Rock Fragments
T08-10	1.6	701.1	0.9	Gray Black Fine to Medium Gravel, Calcareous Broken Rock Fragments
T08-11	1.8	700.9	0.1	Gray Black Fine to Medium Gravel, Calcareous Broken Rock Fragments
T08-12	1.2	701.7	0.2	Gray Black Fine to Medium Gravel, Calcareous Broken Rock Fragments
T08-13	2.8	700.1	0.1	Gray Black Fine to Medium Gravel, Calcareous Broken Rock Fragments
T08-14	1.9	700.7	0.0	River Run Rock, Restoration Materials
T08-15	0.0	705.6	0.0	River Run Rock, Restoration Materials
T09-01	NA	707.3	1.0	Point Falls in Restoration Top Soil
T09-02	NA	706.2	1.2	Point Falls in Restoration Top Soil
T09-03	NA	704.8	2.3	5 feet from Edge of Water/Black Clay Silt Fine to Medium Sand
T09-04	2.1	702.0	0.1	Rock/Fine to Medium Sand/Fine to Medium Gravel
T09-05	2.1	701.8	0.1	Brown Fine to Medium Sand/Fine Gravel/Calcareous Brown Rock
T09-06	2.3	701.7	0.1	Fine to Medium Gravel, Trace Medium Sand
T09-07	2.3	702.0	0.1	Fine to Medium Gravel, Trace Fine to Medium Sand
T09-08	2.3	701.7	0.1	Gray to Black Fine Sand/Calcareous Broken Rock Fragments/Fine to Medium Gravel
T09-09	2.7	701.6	0.2	Fine to Medium Gravel/Trace Fine to Medium Sand
T09-10	2.9	701.2	0.4	Fine to Medium Gravel
T09-11	3.8	700.7	0.4	Gray Black Silty Clay, Trace Fine Gravel
T09-12	3.5	700.4	1.0	Gray Black Silty Clay, Fine to Medium Gravel at Bottom
T09-13	2.1	702.0	0.4	Gray Black Fine to Medium Sand, Trace Silty Clay, Wood, Leaves, Twigs
T09-14	0.4	703.7	0.6	Rock/Gray Black Silt, Fine Sand, Wood, Twigs, Leaves
T09-15	0.0	707.2	3.7	5 feet from Edge of Water/Brown Fine to Medium Sand, Roots, Twigs, Vegetation
T10-01	NA	NA	NA	River Run Rock
T10-02	1.9	703.8	0.1	Fine Gravel/Rock
T10-03	2.3	703.6	0.1	Fine Gravel/Rock
T10-04	2.0	704.0	0.1	Fine to Coarse Gravel/Rock
T10-05	1.9	704.0	0.2	Fine to Medium Gravel/Rock
T10-06	2.7	703.1	0.2	Gray Brown Fine to Medium Sand/Fine to Medium Gravel/Trace Silt
T10-07	2.4	703.5	0.1	Fine to Medium Sand/Fine Gravel/Calcareous Broken Rock

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Supplemental Remedial Investigations/Feasibility Studies
Former Plainwell Impoundment TCRA July 2009 Post-Removal Bathymetry Monitoring Results
and Mid-Channel Prism Volume Remaining

Table 1 -- July 2009 Bathymetric Survey in the Former Plainwell Impoundment

Transect - Station ID	Water Depth (ft)	Top of Sediment Elevation (ft, NGVD 1929)	Probe Depth (ft)	Description
T10-08	2.5	703.6	0.3	Brown Fine Sand/Fine to Medium Gravel
T10-09	1.7	704.2	0.6	Brown and Black Fine to Medium Sand/Fine to Medium Gravel and Wood
T10-10	1.2	704.5	0.6	Brown and Black Fine to Medium Sand/Fine to Medium Gravel and Silt
T10-11	1.0	704.8	0.3	Vegetation, Gray Brown Fine to Medium Sand/Fine to Medium Gravel, Silty
T10-12	1.1	704.6	0.9	Brown and Black Fine to Medium Sand/Fine to Medium Gravel and Silt
T10-13	1.2	704.4	0.7	Gray and Black Fine to Medium Gravel/Calcareous Rock
T10-14	1.4	704.6	0.6	Brown Fine Silt/Silt, Fine to Medium Gravel
T10-15	NA	NA	NA	River Run Rock

Notes:

1. NA = not available

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Table 2 -- Mid-Channel Sediment Prism Volume Calculations as of July 2009

Transect	Length (ft)	2006 Mid Channel Area (ft ²) ¹	2009 Mid Channel Area (ft ²) ¹	2006 Prism Volume (cy)	2009 Prism Volume (cy)	July 2009 Net Volume Change Relative to 2006 (%)	July 2009 Net Volume Change Relative to 2006 (%) ⁵
T01	210	1,800 ²	810	13,000	6,200	-54%	-54%
T02	240	1,000 ³	470	8,900	4,200	-53%	-53%
T03	220	1,100	-330	8,500	-2,700	-131%	-100%
T04	130	680	320	3,400	1,600	-53%	-53%
T05	250	570	-220	5,200	-2,000	-139%	-100%
T06	740	750	280	20,000	7,700	-62%	-62%
T07	650	330	36	8,000	870	-89%	-89%
T08	770	340	140	9,600	4,000	-58%	-58%
T09	800	15	-80	440	-2,400	-633%	-100%
T10	780	340	310	9,900	8,900	-11%	-11%
Total Volume				88,000	26,000	-70%	-62%
T08 Through T10				20,000	11,000	-47%	-35%
T01 Through T07				68,000	16,000	-77%	-70%

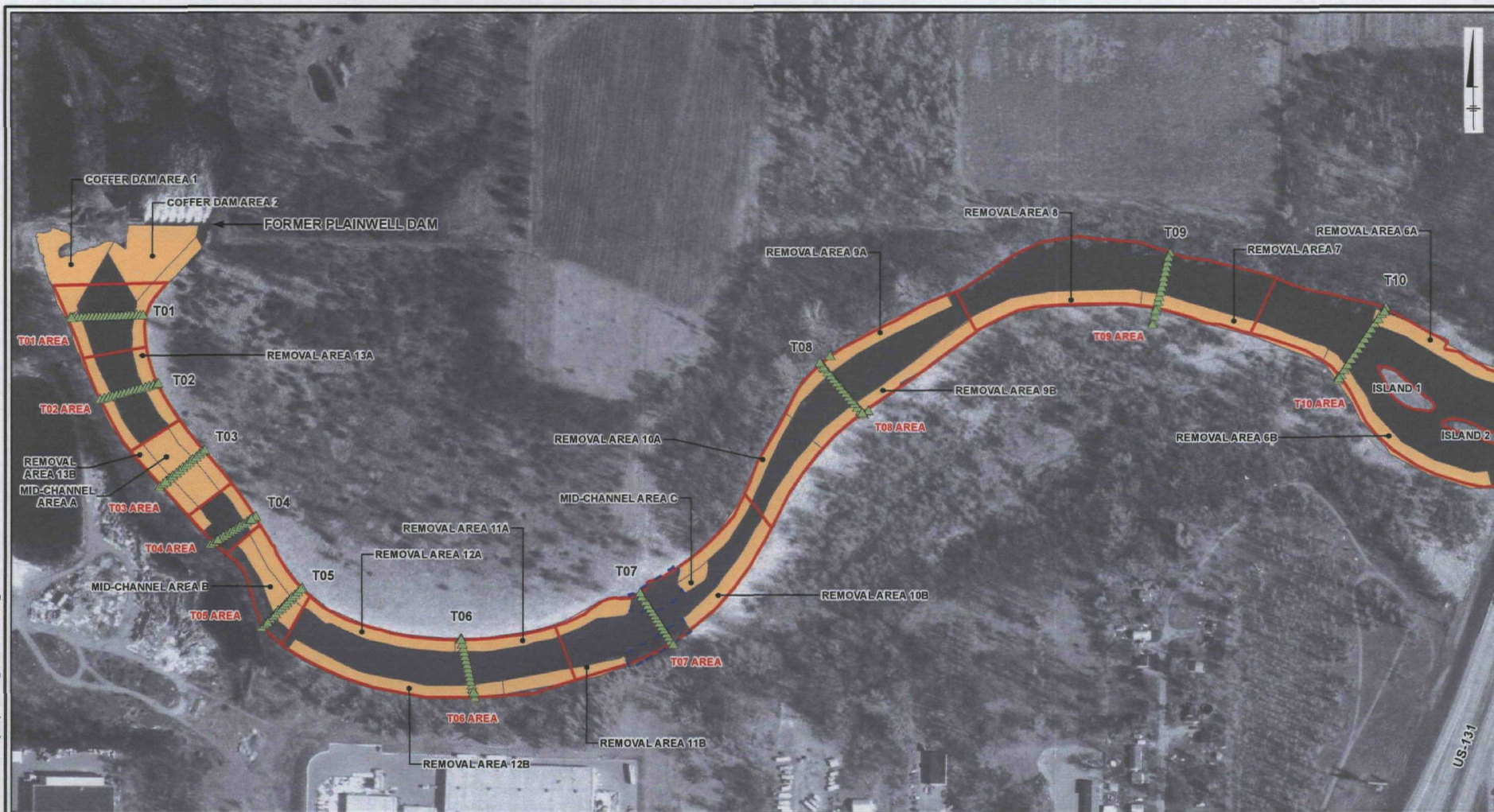
Notes:

1. Area of the mid-channel prism was calculated using CAD software.
2. Bathymetry survey was not completed in 2006 at Transect T1. The sediment prism area is calculated from available 2000 pre-removal data.
3. Bathymetry survey was not completed in 2006 at Transect T2. The sediment prism area is calculated from 2007 data.
4. Negative mid-channel areas calculated for transects where the sediment elevation is below the 2000 USGS pre-impoundment elevation.
5. Where July 2009 prism volume is negative (i.e. elevations below estimated pre-impoundment river bottom elevation) those remaining "prism" volumes were set to zero in calculating total prism volume remaining.

ARCADIS

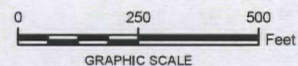
Figures

SYR-345 MTK
KRS-0 (64520.00679)
Q:\KRS-0 Plainwell_TCRA Bathymetry_2009_PostRemoval.mxd Bathymetry Transects_v9.mxd - 10/6/2009 @ 1:11:38 PM



LEGEND:

- ▲ BATHYMETRY DATA POINT - JULY 2009
- SEDIMENT REMOVAL AREA
- REMOVAL AREA NOT EXCAVATED DUE TO THE PRESENCE OF BURIED GAS LINES
- SEDIMENT VOLUME CALCULATION AREA



NOTES:

1. AERIAL IMAGE DERIVED FROM ORTHOGRAPHIC DATA BY AIR LAND SURVEYS, INC. KALAMAZOO RIVER FLOWN 4/24/99.
2. BATHYMETRY DATA POINTS WERE COLLECTED ON JULY 16, 2009.

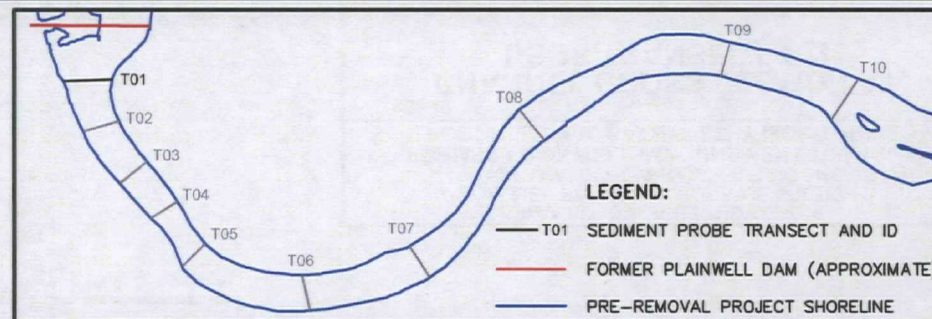
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**BATHYMETRY TRANSECTS
PLAINWELL TCRA AREA**



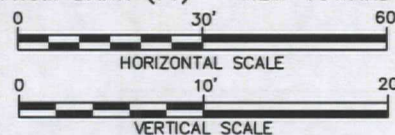
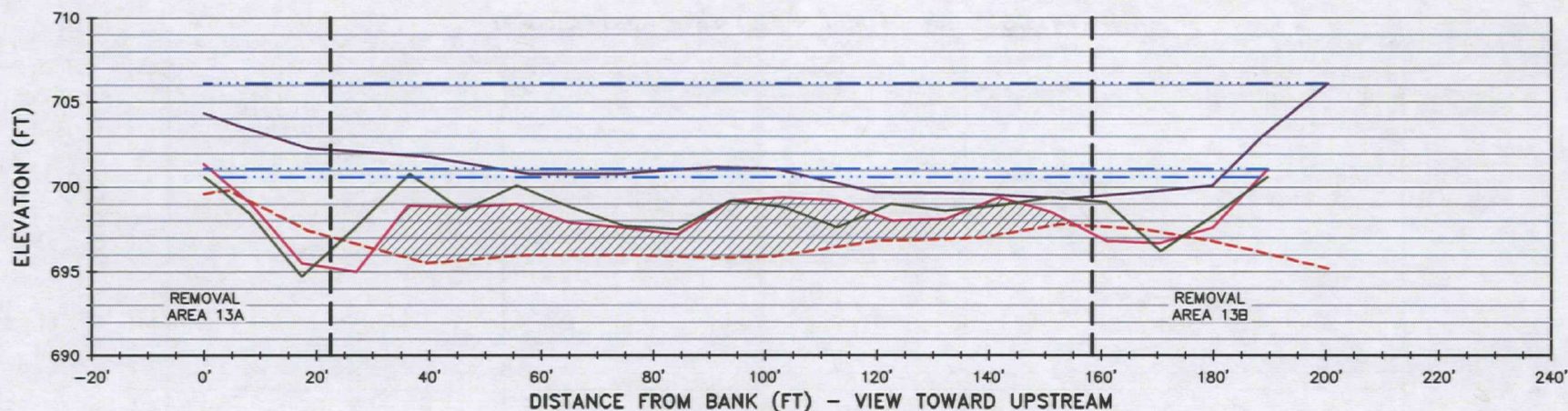
FIGURE
1

XREFS: IMAGES: PROJECTNAME: ---
 64530X00
 64530X01



INSET MAP

SCALE: 1"=800'



LEGEND:

- 2000 WATER SURFACE ELEVATION
- MARCH 2009 WATER SURFACE ELEVATION, FLOW: 1500 CFS 3/26/09
- JULY 2009 WATER SURFACE ELEVATION, FLOW: 775 CFS 7/16/09
- 2000 SEDIMENT SURFACE ELEVATION
- MARCH 2009 SEDIMENT SURFACE ELEVATION
- JULY 2009 SEDIMENT SURFACE ELEVATION
- 2000 USGS PRE-IMPOUNDMENT RIVER BOTTOM
- APPROXIMATE LIMIT OF REMOVAL AREA
- 2009 MID-CHANNEL SEDIMENT PRISM

NOTES:

1. RIVER FLOW MEASURED AT USGS GAGING STATION - KALAMAZOO RIVER, COMSTOCK, MI.
2. PRE-IMPOUNDMENT RIVER BOTTOM ESTABLISHED BY USGS IN 2000 REPORT.

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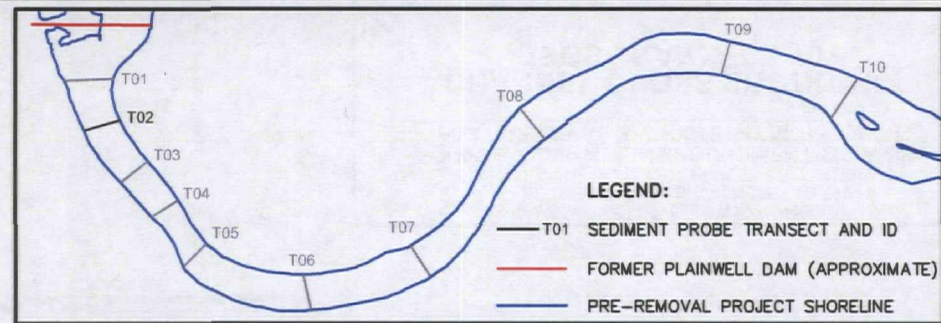
**CHANNEL CROSS SECTION AT
 USGS TRANSECT T01**



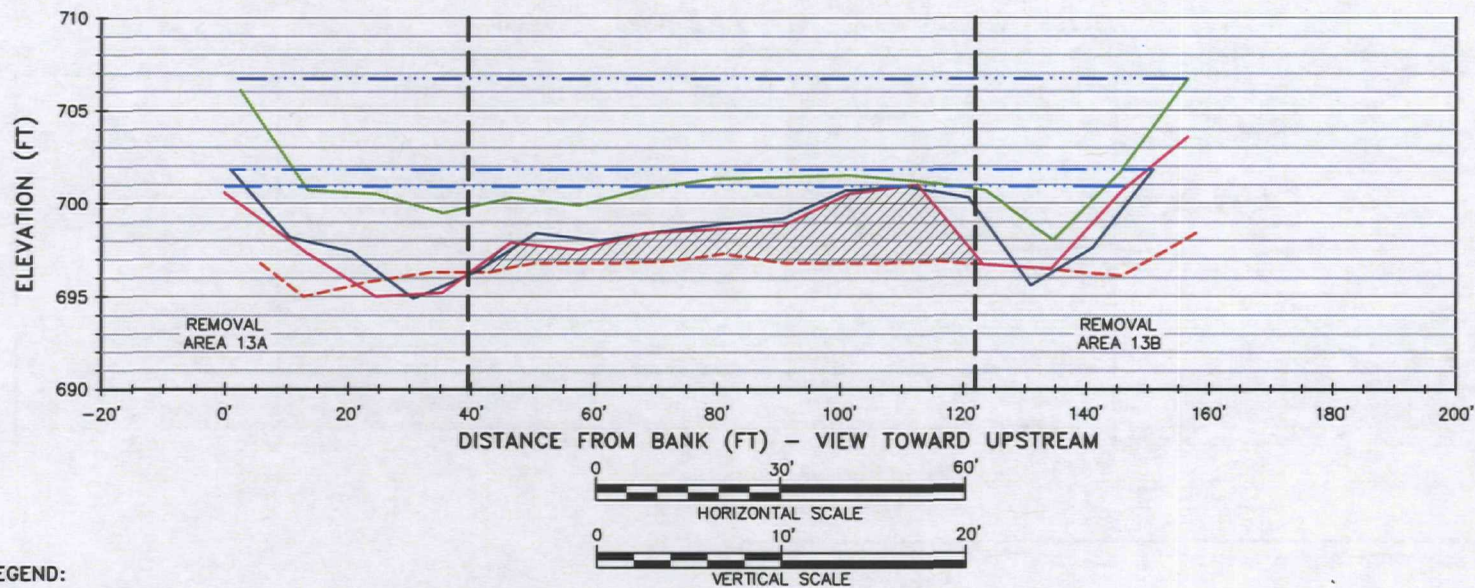
FIGURE

2

XREFS: IMAGES: PROJECTNAME: ---
64530X00
64530X01



INSET MAP
SCALE: 1"=800'



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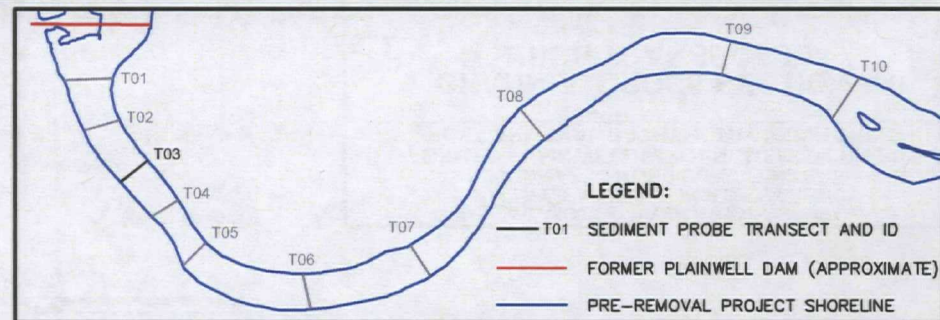
CHANNEL CROSS SECTION AT USGS TRANSECT T02



FIGURE

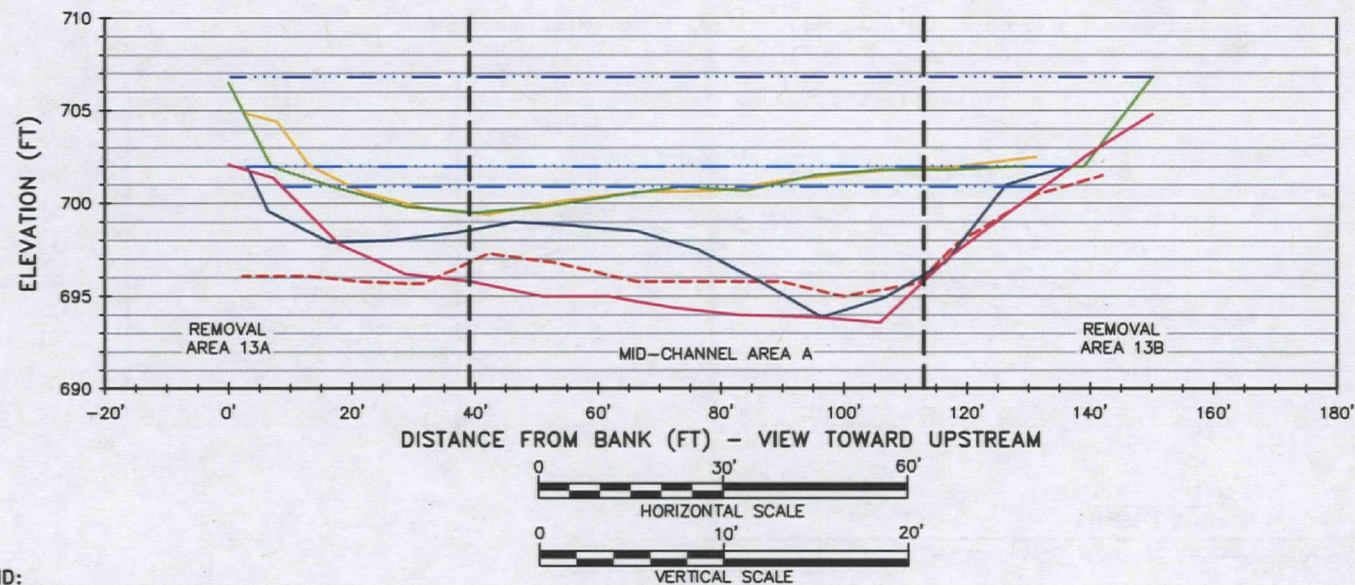
3

XREFS: IMAGES: PROJECTNAME: ---
 64530X00
 64530X01



INSET MAP

SCALE: 1"=800'



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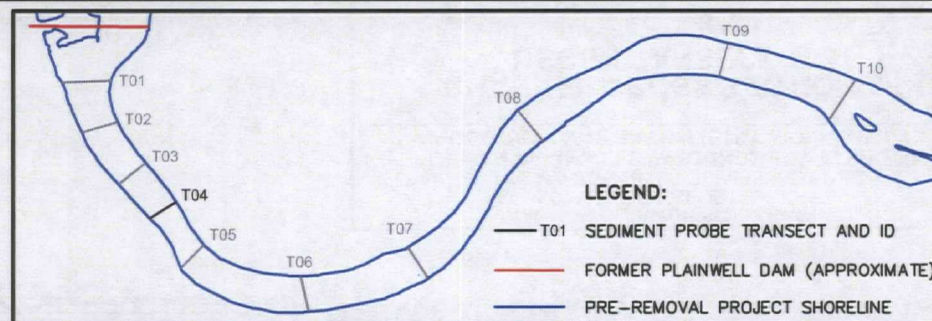
CHANNEL CROSS SECTION AT USGS TRANSECT T03



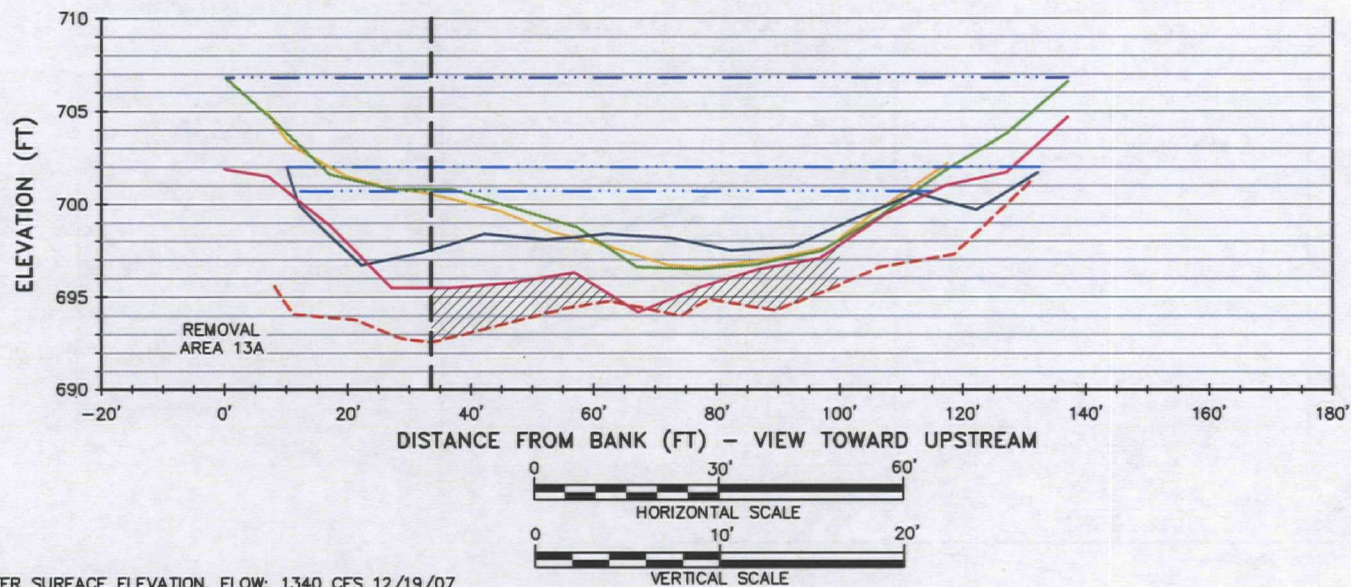
FIGURE

4

XREFS: IMAGES: PROJECTNAME: ---
64530X00
64530X01



INSET MAP
SCALE: 1"=800'



LEGEND:

- 2007 WATER SURFACE ELEVATION, FLOW: 1340 CFS 12/19/07
- 2008 WATER SURFACE ELEVATION, FLOW: 934 CFS 12/4/08
- 2009 WATER SURFACE ELEVATION, FLOW: 775 CFS 7/16/09
- SEPTEMBER 2006 SEDIMENT SURFACE ELEVATION
- DECEMBER 2007 SEDIMENT SURFACE ELEVATION
- DECEMBER 2008 SEDIMENT SURFACE ELEVATION
- JULY 2009 SEDIMENT SURFACE ELEVATION
- 2000 USGS PRE-IMPOUNDMENT RIVER BOTTOM
- APPROXIMATE LIMIT OF REMOVAL AREA
- ▨ 2009 MID-CHANNEL SEDIMENT PRISM

NOTES:

1. RIVER FLOW MEASURED AT USGS GAGING STATION - KALAMAZOO RIVER, COMSTOCK, MI.
2. PRE-IMPOUNDMENT RIVER BOTTOM ESTABLISHED BY USGS IN 2000 REPORT.

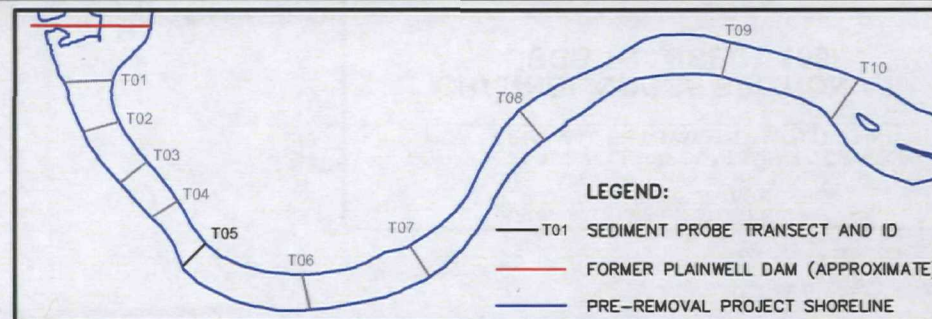
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**CHANNEL CROSS SECTION AT
USGS TRANSECT T04**



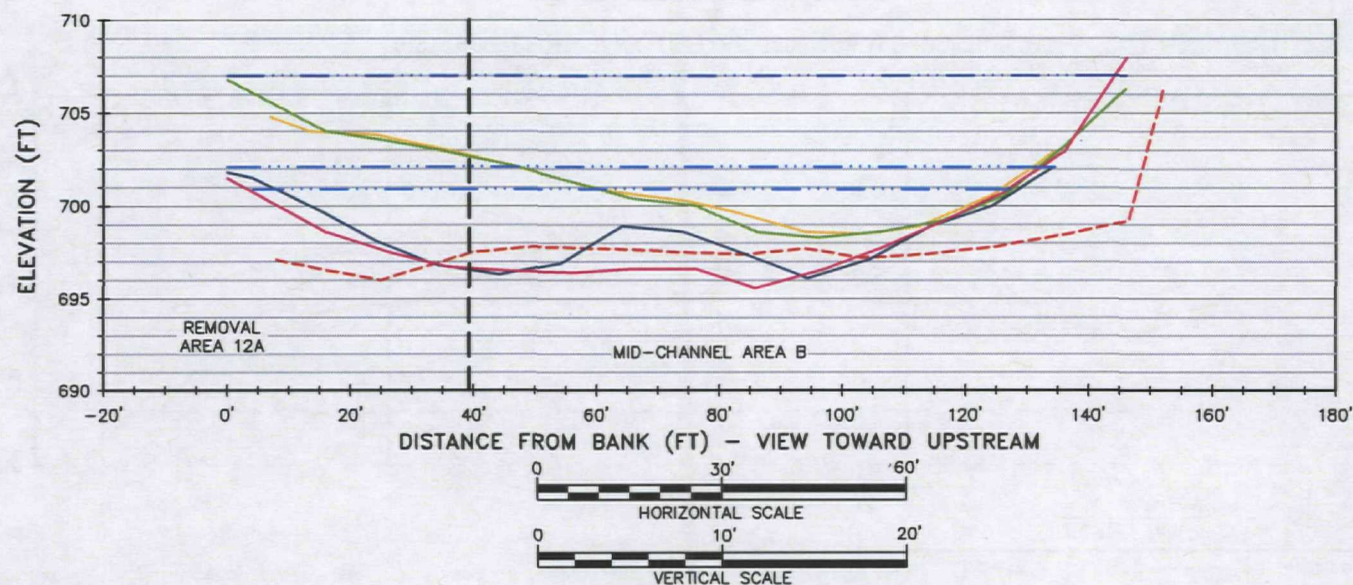
FIGURE
5

XREFS: IMAGES: PROJECTNAME: ---
64530X00
64530X01



INSET MAP

SCALE: 1"=800'



LEGEND:

- 2007 WATER SURFACE ELEVATION, FLOW: 1340 CFS 12/19/07
- 2008 WATER SURFACE ELEVATION, FLOW: 934 CFS 12/4/08
- 2009 WATER SURFACE ELEVATION, FLOW: 692 CFS 7/14/09
- SEPTEMBER 2006 SEDIMENT SURFACE ELEVATION
- DECEMBER 2007 SEDIMENT SURFACE ELEVATION
- DECEMBER 2008 SEDIMENT SURFACE ELEVATION
- JULY 2009 SEDIMENT SURFACE ELEVATION
- - - 2000 USGS PRE-IMPOUNDMENT RIVER BOTTOM
- - - APPROXIMATE LIMIT OF REMOVAL AREA

NOTES:

1. RIVER FLOW MEASURED AT USGS GAGING STATION - KALAMAZOO RIVER, COMSTOCK, MI.
2. PRE-IMPOUNDMENT RIVER BOTTOM ESTABLISHED BY USGS IN 2000 REPORT.

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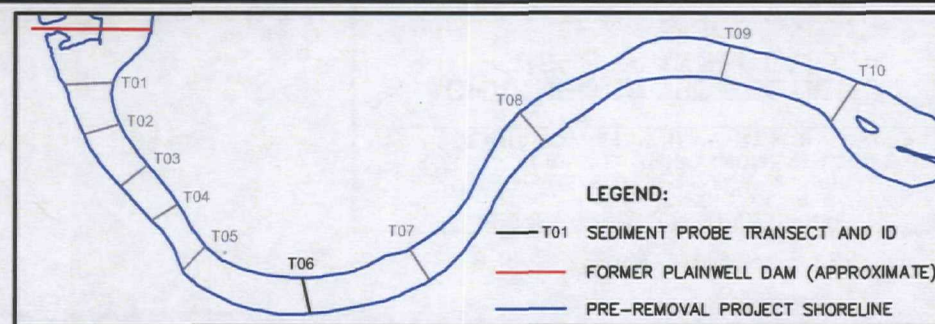
**CHANNEL CROSS SECTION AT
USGS TRANSECT T05**



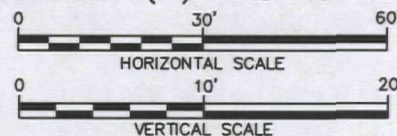
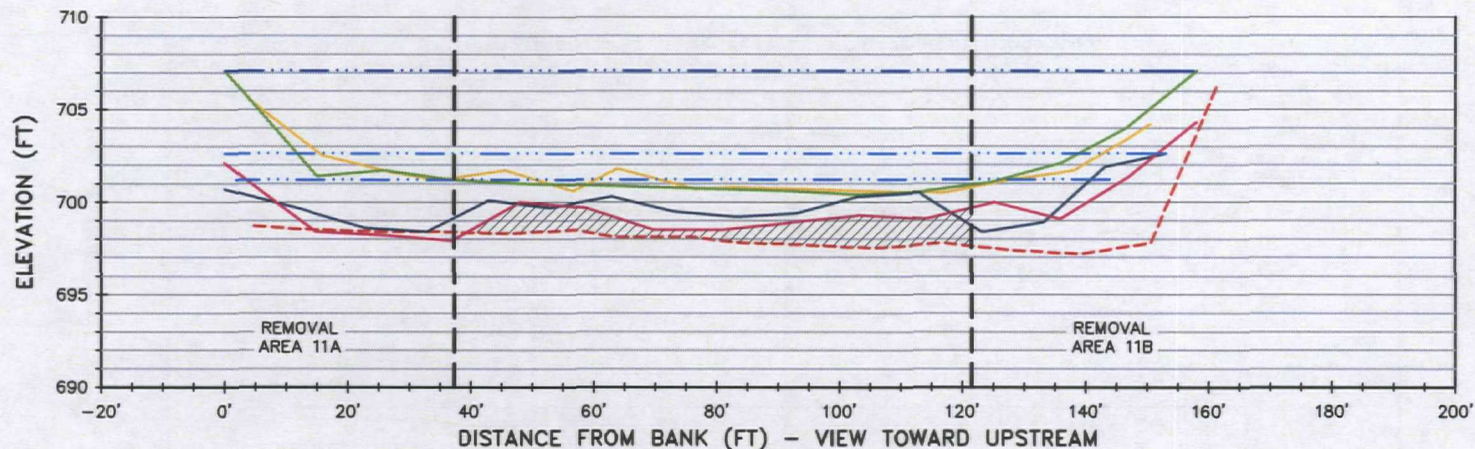
FIGURE

6

XREFS: IMAGES: PROJECTNAME: ---
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 64530X01



INSET MAP
 SCALE: 1"=800'



NOTES:

1. RIVER FLOW MEASURED AT USGS GAGING STATION - KALAMAZOO RIVER, COMSTOCK, MI.
2. PRE-IMPOUNDMENT RIVER BOTTOM ESTABLISHED BY USGS IN 2000 REPORT.

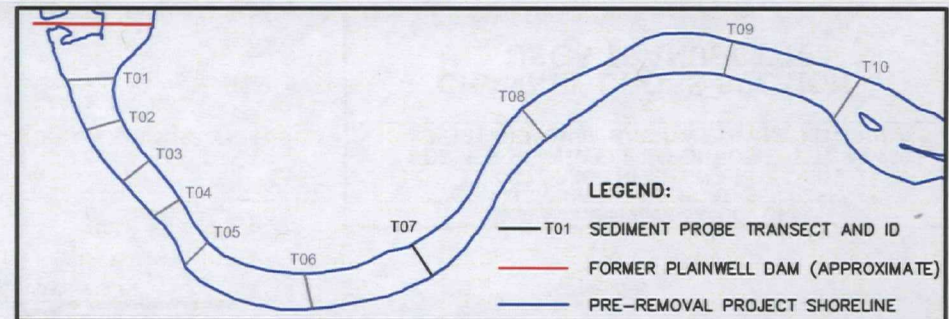
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**CHANNEL CROSS SECTION AT
 USGS TRANSECT T06**

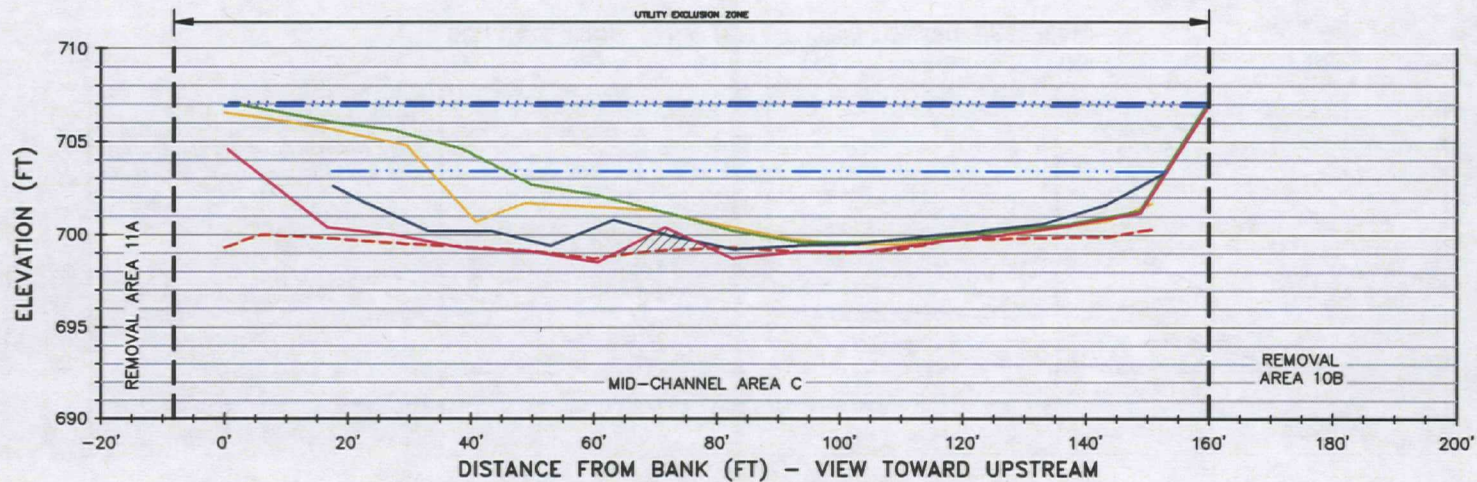


FIGURE
7

XREFS: IMAGES: PROJECTNAME: ---
 64530X00
 64530X01

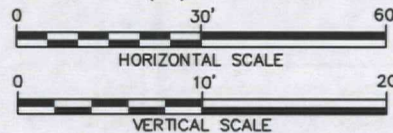


INSET MAP
 SCALE: 1"=800'



LEGEND:

- 2007 WATER SURFACE ELEVATION, FLOW: 1340 CFS 12/19/07
- 2008 WATER SURFACE ELEVATION, FLOW: 934 CFS 12/4/08
- 2009 WATER SURFACE ELEVATION, FLOW: 692 CFS 7/14/09
- SEPTEMBER 2006 SEDIMENT SURFACE ELEVATION
- DECEMBER 2007 SEDIMENT SURFACE ELEVATION
- DECEMBER 2008 SEDIMENT SURFACE ELEVATION
- JULY 2009 SEDIMENT SURFACE ELEVATION
- - - 2000 USGS PRE-IMPOUNDMENT RIVER BOTTOM
- - - APPROXIMATE LIMIT OF REMOVAL AREA
- ▨ 2009 MID-CHANNEL SEDIMENT PRISM



NOTES:

1. RIVER FLOW MEASURED AT USGS GAGING STATION - KALAMAZOO RIVER, COMSTOCK, MI.
2. PRE-IMPOUNDMENT RIVER BOTTOM ESTABLISHED BY USGS IN 2000 REPORT.

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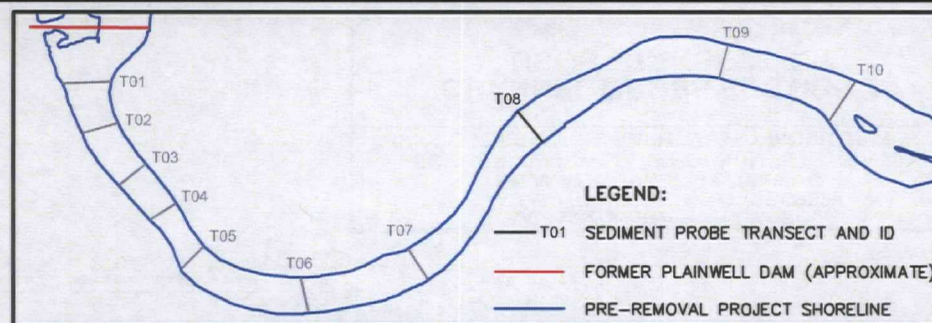
**CHANNEL CROSS SECTION AT
 USGS TRANSECT T07**



FIGURE

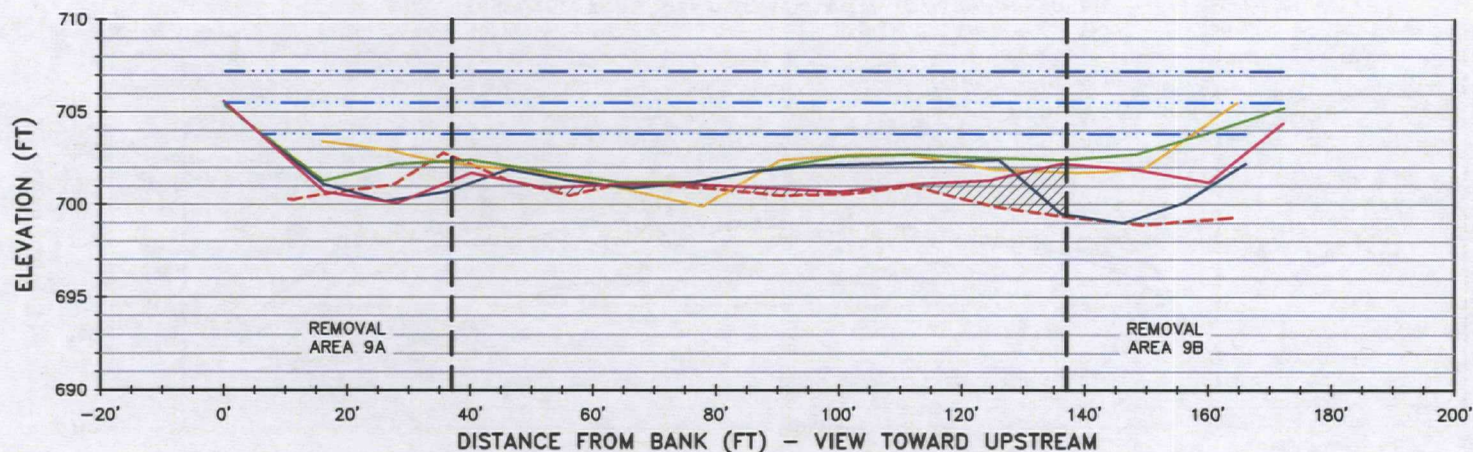
8

XREFS: IMAGES: PROJECTNAME: ---
64530X00
64530X01



INSET MAP

SCALE: 1"=800'



LEGEND:

- 2007 WATER SURFACE ELEVATION, FLOW: 1340 CFS 12/19/07
- 2008 WATER SURFACE ELEVATION, FLOW: 934 CFS 12/4/08
- 2009 WATER SURFACE ELEVATION, FLOW: 836 CFS 7/15/09
- SEPTEMBER 2006 SEDIMENT SURFACE ELEVATION
- DECEMBER 2007 SEDIMENT SURFACE ELEVATION
- DECEMBER 2008 SEDIMENT SURFACE ELEVATION
- JULY 2009 SEDIMENT SURFACE ELEVATION
- 2000 USGS PRE-IMPOUNDMENT RIVER BOTTOM
- APPROXIMATE LIMIT OF REMOVAL AREA
- ▨ 2009 MID-CHANNEL SEDIMENT PRISM

NOTES:

1. RIVER FLOW MEASURED AT USGS GAGING STATION - KALAMAZOO RIVER, COMSTOCK, MI.
2. PRE-IMPOUNDMENT RIVER BOTTOM ESTABLISHED BY USGS IN 2000 REPORT.

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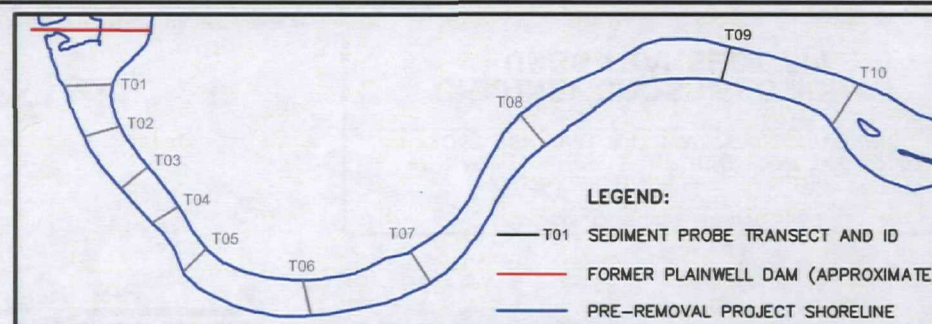
**CHANNEL CROSS SECTION AT
USGS TRANSECT T08**



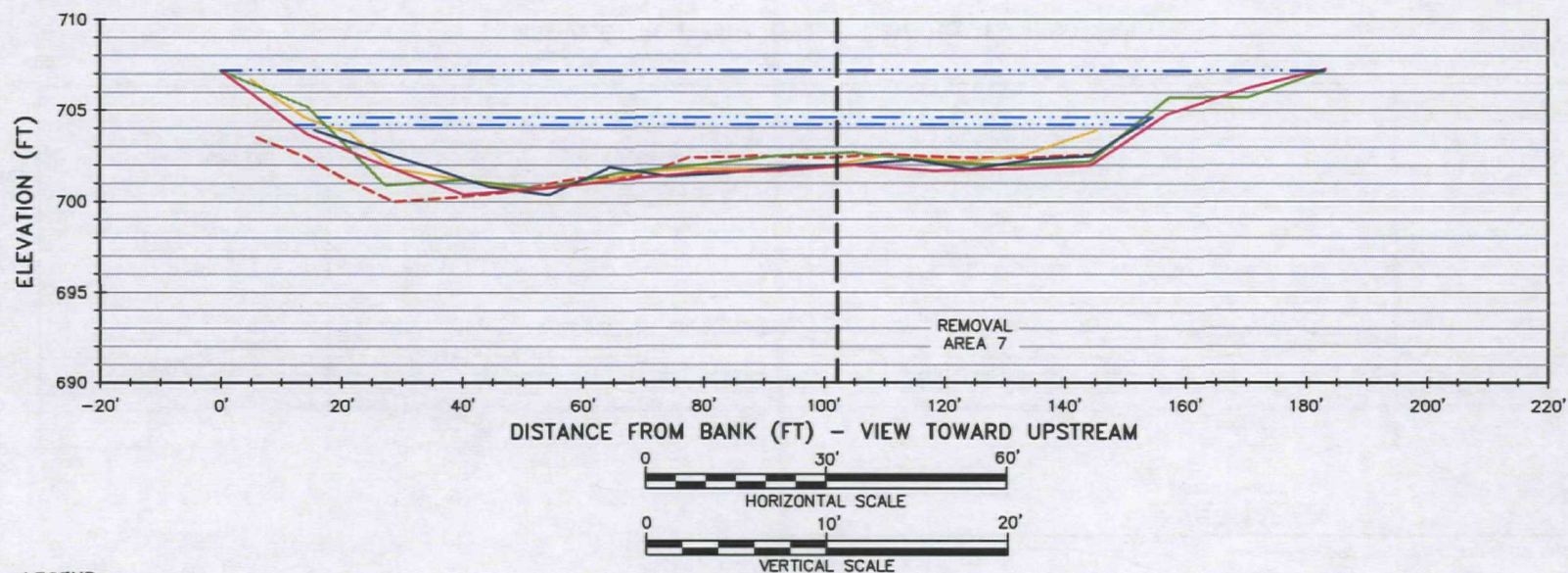
FIGURE

9

XREFS: IMAGES: PROJECTNAME: ---
64530X00
64530X01



INSET MAP
SCALE: 1"=800'



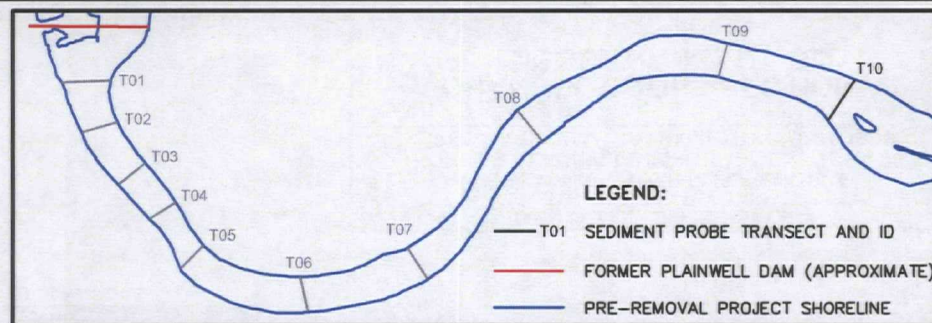
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CHANNEL CROSS SECTION AT USGS TRANSECT T09



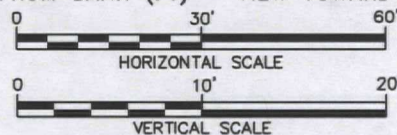
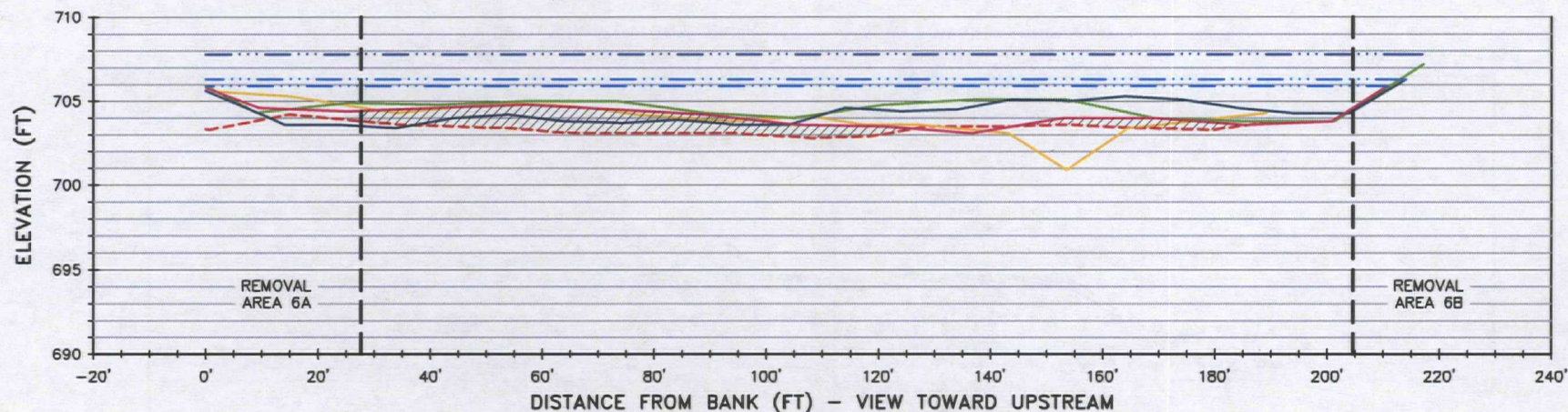
FIGURE
10

XREFS: IMAGES: PROJECTNAME: ---
 64530X00
 64530X01



INSET MAP

SCALE: 1"=800'



NOTES:

1. RIVER FLOW MEASURED AT USGS GAGING STATION - KALAMAZOO RIVER, COMSTOCK, MI.
2. PRE-IMPOUNDMENT RIVER BOTTOM ESTABLISHED BY USGS IN 2000 REPORT.

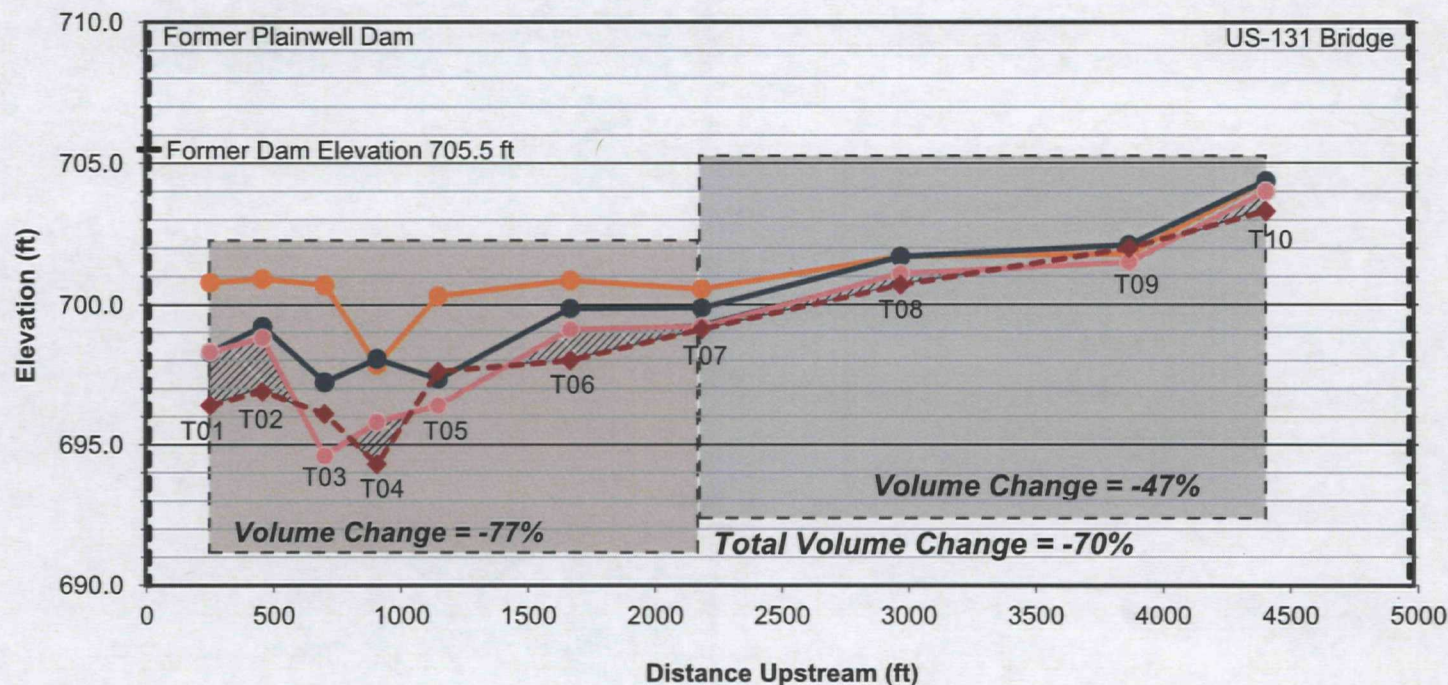
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**CHANNEL CROSS SECTION AT
 USGS TRANSECT T10**



FIGURE

11



NOTES:

1. Transect T02 was not surveyed in 2006. The prism elevation at this location is from 2007 survey data.
2. Transect T01 was not surveyed in 2006. The prism elevation at this location is from 2000 survey data.
3. Transect T01 was not surveyed in 2008, but was surveyed in March 2009 after removal of cofferdam structures.

LEGEND:

- September 2006 Average Mid-Channel Prism Elevation
- December 2008 Average Mid-Channel Prism Elevation
- July 2009 Average Mid-Channel Prism Elevation
- ◆— 2000 Average USGS Pre-impoundment River Bottom
- July 2009 Mid-Channel Sediment Prism

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**LONGITUDINAL PROFILE OF
MID-CHANNEL SEDIMENT PRISM**



FIGURE
12